

REMARKS

This timely filed Reply is in response to the Office Action mailed November 16, 2005. Claims 48-70 were pending at the time of the Office Action. Claims 48-54 and 57-60 were rejected based on cited art, while claims 55-56 and 61-70 were objected to as being dependent upon a rejected claim, but were determined to be allowable if rewritten in independent form.

In this Reply paragraph 7 of the specification has been amended to correct a minor typographical error and claims 48-50, 57, 59 and 69 have been amended. No new matter has been added.

Claims 48, 50-54 and 57 were rejected under 35 U.S.C. §103(a) as being unpatentable over Dozier, II et al. (US Pat. No. 6,669,489) in view of Tai et al. (U.S. Pub. No. US 20010033670). Claim 49 was rejected under 35 U.S.C. §103(a) as being unpatentable over Dozier and Tai in view of Humphreys, Jr. et al. ("Design and Use of Microphone Directional Arrays for Aeroacoustic Measurements" AIAA Paper 98-0471). Claims 58-60 were rejected under 35 U.S.C. §103(a) as being unpatentable over Dozier and Tai, further in view of Criglar et al. (US Pat. No. 4,119,007).

Before reviewing the cited art, Applicants' will first review the claimed invention as now recited in amended claim 48. Amended claim 48 recites a printed circuit board array responsive to aeroacoustic waves, comprising:

- a. a printed circuit board having a first surface and an opposing second surface;
- b. a plurality of sockets distributed over the first surface of the printed circuit board;
- c. a plurality of microphone packages, wherein each microphone package is received in a corresponding socket and contains at least one microphone responsive to an aeroacoustic wave, each of said microphones including a semiconductor substrate, a cavity formed in said substrate, a diaphragm covering said cavity, and a vent channel in fluid communication with said cavity and an atmosphere surrounding said array, and
- d. at least one signal processor disposed on said circuit board, an input of said signal processor coupled to outputs of said plurality microphone packages, said processor beamforming signals received from said plurality of microphone packages and outputting a combined signal therefrom.

Support for the claimed aeroacoustic wave aspect can be found throughout Applicants' specification. Aeroacoustics are important for airplane noise testing and are generally performed in aeroacoustic wind tunnels using scale models of airplanes. Aeroacoustic sensor based test systems are generally required to process signals up to about 90 kHz having a dynamic range from 25 to 160 dB, which generate up to about 10 atmospheres of pressure. In contrast, audio devices are designed to operate with audio signals up to only about 20 kHz, having a dynamic range of 25 to 120 dB, which generate a pressure near 1 atmosphere (atmospheric) pressure.

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The specification description accompanying Figs 3A and 3B provides support for the claimed "semiconductor substrate, a cavity formed in said substrate, a diaphragm covering said cavity, and a vent channel in fluid communication with said cavity and an atmosphere surrounding said array" Vent channel is identified as reference 330 in Figs 3A and 3B. The claimed microphone vent channel in fluid communication with the cavity and an atmosphere surrounding the array is an important feature for aeroacoustic applications. The vent provides pressure equalization. Without pressure equalization the thin membrane/diaphragm would collapse under normal operating wind tunnel aeroacoustic test conditions which can subject the membrane/diaphragm to up to 10 atmospheres of pressure, or more.

Support for the beamforming signal processor receiving signals from the plurality of sensors can be found in the specification with regard to Fig. 8:

As shown in FIG. 8, an airplane 801 is radiating spherical waves 803, which is received by an acoustic array 880 of the present invention. Each microphone 802 in the array 880 senses a slightly different phase-shifted waveform and generates a signal responsive to the acoustic wave 803. The signal is amplified by each corresponding amplifier 804. The total signal can be further processed by processing chip(s) 820.

Further support for the beamforming signal processor receiving signals from a plurality of sensors can be found in Fig. 8 as well as paragraph 52 with reference to Fig. 1 (copied below):

As illustrated in FIG. 1, a monopole acoustic source 1 is radiating spherical waves 3 into a homogeneous quiescent medium fixed in space, where an acoustic array 5 is positioned. Each microphone 2 in the array 5 senses a slightly different phase-shifted waveform 7 depending on its distance from the source 1 due to propagation delay. The array 5 can be focused on the source 1 by phase shifting the microphones through phase shifting device 4 and then summing the output 7' from each microphone at a summation device 6, which in turn generates a signal 9 responsive to the acoustic wave 3. This process is commonly referred to as delay-and-sum beamforming. The beamforming technique permits the measurement of noise from predefined regions in space, while providing signal rejection for sources located outside of the acoustic beam.

Dozier is entitled "Interposer, socket and assembly for socketing an electronic component and method of making and using same". Dozier discloses surface-mount, solder-down sockets which permit semiconductor packages to be releasably mounted to a circuit board or other electronic component. In an embodiment, resilient contact structures extend through a support substrate, and solder-ball (or other suitable) contact structures are disposed along the bottom of the support substrate in electrical contact with the ends of the resilient contact structures. The invention is disclosed particularly for making interconnections between a plurality of packaged semiconductor devices mounted to a circuit board. There is no mention of any acoustic devices (e.g. microphones) in Dozier.

Tai discloses an electret formed by micro-machining technology (MEMS) on a support surface, including a self-powered electret sound transducer, preferably in the form of a microphone, formed by

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micro-machining technology. Each microphone is manufactured as a two-piece unit, comprising a microphone membrane unit and a microphone back plate, at least one of which includes an electret formed by micro-machining technology. When juxtaposed, the two units form a microphone that can produce a signal without the need for external biasing, thereby reducing system volume and complexity. The capacitance-based electret microphone does not include a vent and is only suitable as an audio device and is disclosed for use as the same (see paragraph 46). Tai only relates to one or more MEMS microphone and supporting electronic circuitry on the same chip/die, and thus teaches away from disposing multiple microphone comprising die on a circuit board. For example, paragraph 65 discloses:

Since the MEMS processes used in fabricating electrets and electret microphones in accordance with the present invention are compatible with fabrication of integrated circuitry, such devices as amplifiers, signal processors, filters, A/D converters, etc., can be fabricated inexpensively as an integral part of the electret-based device. Further, the low cost of manufacture and the ability to make multiple microphones on a substrate wafer permits use of multiple microphones in one unit, for redundancy or to provide directional sound perception.

Criglar discloses a pressure transducer comprised of a piezoresistance bridge on a semiconductor chip employed as a pressure sensor in musical instruments having an air column through which pressure variations pass in producing sounds, such as in wind instruments and drums. A noiseless voltage preamplifier on the chip couples the transducer to a power preamplifier the output of which may then be amplified in a conventional audio amplifier. Criglar's pressure transducer is disclosed for audio operation. Criglar does not hint at including disposing a plurality of pressure transducer comprising chips on a circuit board.

No reference discloses Applicants' claimed plurality of microphone chips on a circuit board. Although Dozier discloses a plurality of packaged semiconductor devices mounted to a circuit board, there is no mention of any acoustic devices (e.g. microphones). Although Tai discloses a plurality of microphones on a chip, Tai teaches only single chip embodiments and thus teaches away from disposing multiple microphone comprising die on a circuit board. Although Criglar discloses a pressure sensor and voltage preamplifier on the same chip, Criglar like Tai does not hint at disposing a plurality of pressure transducer comprising chips on a circuit board.

Other inventive aspects are recited in Applicants' amended claim 48. A second inventive aspect of Applicants' claimed invention is the claimed microphone vent channel in fluid communication with the cavity and an atmosphere surrounding the array. As noted above, this is an important and necessary feature for aeroacoustic applications which can subject the membrane/diaphragm to a pressure of 10 atmospheres, or more. None of the cited reference mentions a microphone vent.

A third inventive aspect of Applicants' claimed invention is Applicants' claimed "processor disposed on said circuit board, an input of said signal processor coupled to outputs of said plurality

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microphone packages, said processor beamforming signals received from said plurality of microphone packages and outputting a combined signal therefrom". No cited reference discloses a signal processor for beamforming a plurality of signals. Accordingly, Applicants submit that amended claim 48 and its respective dependent claims are patentable over the cited art.

Applicants have made every effort to present claims which distinguish over the cited art, and it is believed that all claims are now in condition for allowance. However, Applicants invite the Examiner to call the undersigned (direct line (561) 671-3662) if it is believed that a telephonic interview would expedite the prosecution of the application to an allowance. Although no fees are believed due with the filing of this timely Reply, the Commissioner for Patents and Trademarks is hereby authorized to charge any deficiency in any fees due with the filing of this paper or credit any overpayment in any fees paid on the filing, or during prosecution of this application to Deposit Account No. 50-0951.

Respectfully submitted,

AKERMANN SENTERFITT

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Neil R. Jetter
Registration No. 46,803
AKERMANN SENTERFITT
P.O. Box 3188
West Palm Beach, FL 33402-3188
Tel: 561-653-5000

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